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THE OCCURRENCE OF *MOLGULA MANHATTENSIS* (DE KAY) IN BRACKISH WATER NEAR HIROSHIMA, JAPAN[1)]

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With Text-figures 1-4

In January this year, Mr. Tateo Wakimoto, one of the last author's pupils, found two solitary ascidians in a somewhat polluted salty pond just near Takehara Railway Station about 68 km east from Hiroshima. One of these ascidians was sent to the first author for identification. It was identified easily and clearly with *Molgula manhattensis* (De Kay) which is "the commonest and most conspicuous simple ascidian on the Atlantic coast from Massachusetts southward to Chesapeake Bay or beyond" and "will live in highly polluted water and in water of somewhat diminished salinity" (Van Name 1945, p. 388). The European twin of this species has been found in brackish water of 16–30‰ of the Belt Sea and Sound and in some other localities (Hartmeyer 1923, pp. 56–72), but so far any form referable to this species has not yet been reported from the Pacific. Therefore, the present record might be not only interesting as to the distribution of the species but also taxonomically somewhat allusive. To make sure the present identification, the taxonomic description of the examined specimen will be made by the first author and some biological notes on the specimens collected in January to May will be given preliminarily by the last author in the present paper. Before going further, both authors thank heartily Mr. T. Wakimoto for his generosity to submit the specimens he collected to them for examination and also Mr. Osamu Matsushima for his cheerful cooperation in biological surveys.

Molgula manhattensis (De Kay), 1843

(Fig. 1)

The dissected specimen is the largest of the material, roughly ovoid, 25 mm long

1) Contributions from the Seto Marine Biological Laboratory, No. 566.

and 22 mm high, and furnished with long siphons (fig. a); the atrial is longer and 16 mm in length. Both siphons are extended dorsally and somewhat backwards; the branchial is subterminal and the aperture is 6–lobed, while the atrial is situated with its posterior base at the middle of the dorsal side and the aperture is 4–lobed. The animal is attached to the substratum by the left posterior part of the body. The test is thin, gelatinous, faintly milky white and nearly transparent; the alimentary canal and the outline of the right gonad are seen through it. The surface is smooth, but partially encrusted with very fine black sand grains. The mantle is very thin and soft, pale yellowish and transparent, and furnished with a rather weak musculature which consists of several short transverse muscles on the anteroventral side of the body and longitudinal mucsles, on the dorsal side of the body, converging into both siphons.

About a dozen larger branchial tentacles are present; they are built very complicatedly, four orders of branching being defined; branches of Order 4 are, however, rather scarce. A smaller (median) tentacle and two minute ones are set between each pair of larger ones, and two orders of branching are definable even in minute tentacles. In addition to these, a single to a few very minute and simple tentacles are found in respective interspaces, thus the tentacular ring is set very densely with minute to larger tentacles. The dorsal tubercle is situated just ventrally to the large dorsal ganglion; the ciliated groove is S-shaped, but a little deformed (fig. d). Six branchial folds are present, internal longitudinal vessels are arranged as:

Left D 0 (4) 0 (5) 0 (4) 0 (4) 0 (3) 0 (2) 0 V
Right D 0 (4) 0 (5) 0 (5) 0 (4) 0 (3) 0 (3) 0 V.

Plications I to III are slightly lower than plications IV to VI, though the former plications are provided with a little more vessels. There are 5 thick transverse vessels separating 6 transverse infundibular rows, the ventral-most square of respective rows is bisected by a short thinner transverse vessel. A pair of infundibula are formed under each fold in respective transverse infundibular rows, the apex of infundibulum is divided into two tips. The squares framed with thick transverse vessels and branchial plications are each perforated by many elongate stigmata which are arranged very complicatedly to form a number of smaller to larger spirals (fig. e), a few to several of them may become each a small but distinct infundibulum in the ventral-most squares along the endostyle.

The anterior end of the intestinal loop attains the level of the posterior margin of the base of the branchial siphon (fig. b). Very remarkable double loops are formed by the alimentary canal. The first loop is very narrow and its distal part is strongly bent backwards; the dorsal branch of the loop is much thinner than the ventral and is running along the dorsal edge of the latter for the most part, but leaving a space at the distal end of the loop. The second loop is wide and deep; its axis seems to pass through roughly the middle of the ventral branch of the first loop. The oesophagus is short; the proximal half of the ventral branch is slightly thicker, quite devoid of any dark

contents, and probably may represent the gastric region. The liver is occupying the proximal end of this gastric region, somewhat swollen and furnished with dark orange or brownish longitudinal plications which are about a dozen on the exposed side. A

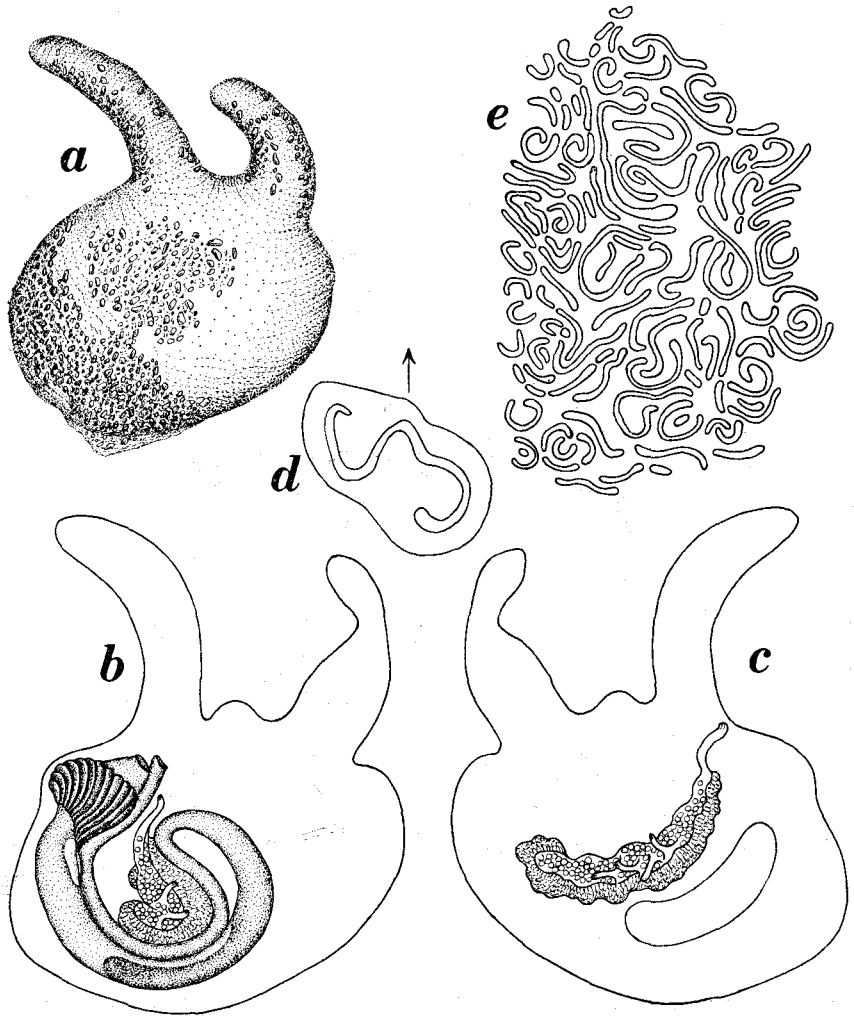

Fig. 1. *Molgula manhattensis* (De Kay) a: the 25 mm long specimen, right side. b: left half of mantle body, internal side. c: right half of mantle body, internal side. d: ciliated groove on dorsal tubercle. e: a part of one of "squares" of branchial sac, ×23.

pair of small whitish elliptical gland-like structures are found at the dorso-posterior corner of the hepatic region. The gastric region and parts following it are coloured orange, and darkly coloured faecal contents are found only in the distal half of the ventral branch of the loop (fig. b) and sparsely in the dorsal branch of the loop. The

anus is plainly margined. The outline and situation of the renal sac are shown in fig. c.

The right gonad is elongate and situated roughly along the dorsal edge of the renal sac, the testis extends along the ventral and posterior sides of the ovary. The left gonad is situated in the second intestinal loop and the testis extends mainly along the anterior and ventral sides of the ovary. The ovary is yellow orange and found in the state of a spent in the examined specimen; the testis is coloured yellow and there are a few to several male genital apertures, in the dissected specimen 4 short ducts in the left and 2 in the right gonad.

Taxonomic remarks: The structure, both internal and external, of the present specimens is exactly the same as that of the specimens of *Molgula manhattensis* (De Kay) from

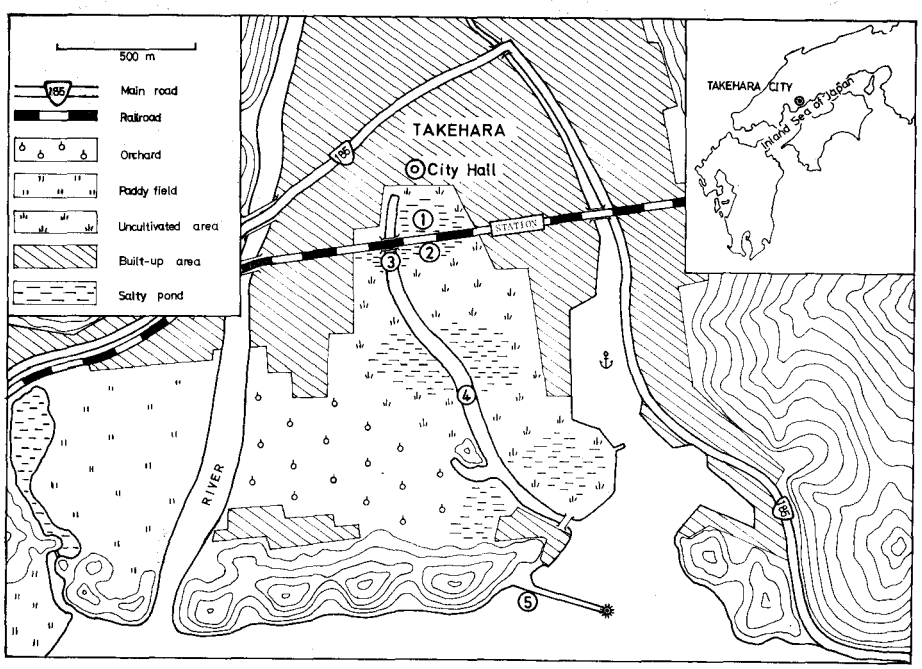

Fig. 2. Map of the area including the habitat (Station 1) of *Molgula manhattensis* (De Kay).

its original localities on the east coast of the United States, which was given in 1945 by Van Name (pp. 358–389, Figs. 271–273; Pl. 10, figs. 2.4; pl. 11, figs. 3, 4). The S-shaped ciliated groove in the present dissected specimen differs somewhat from the C or horseshoe shaped groove shown by Van Name, though such a difference is not unusual and taxonomically of a minor significance.

Environmental conditions of the present specimens conform well to those of the specimens from the east coasts of the United States and also to those of the European twin of the species. Finding of *M. manhattensis* in the Japanese waters seems to show on one hand a possibility of circumpolar distribution of this species, and on the other

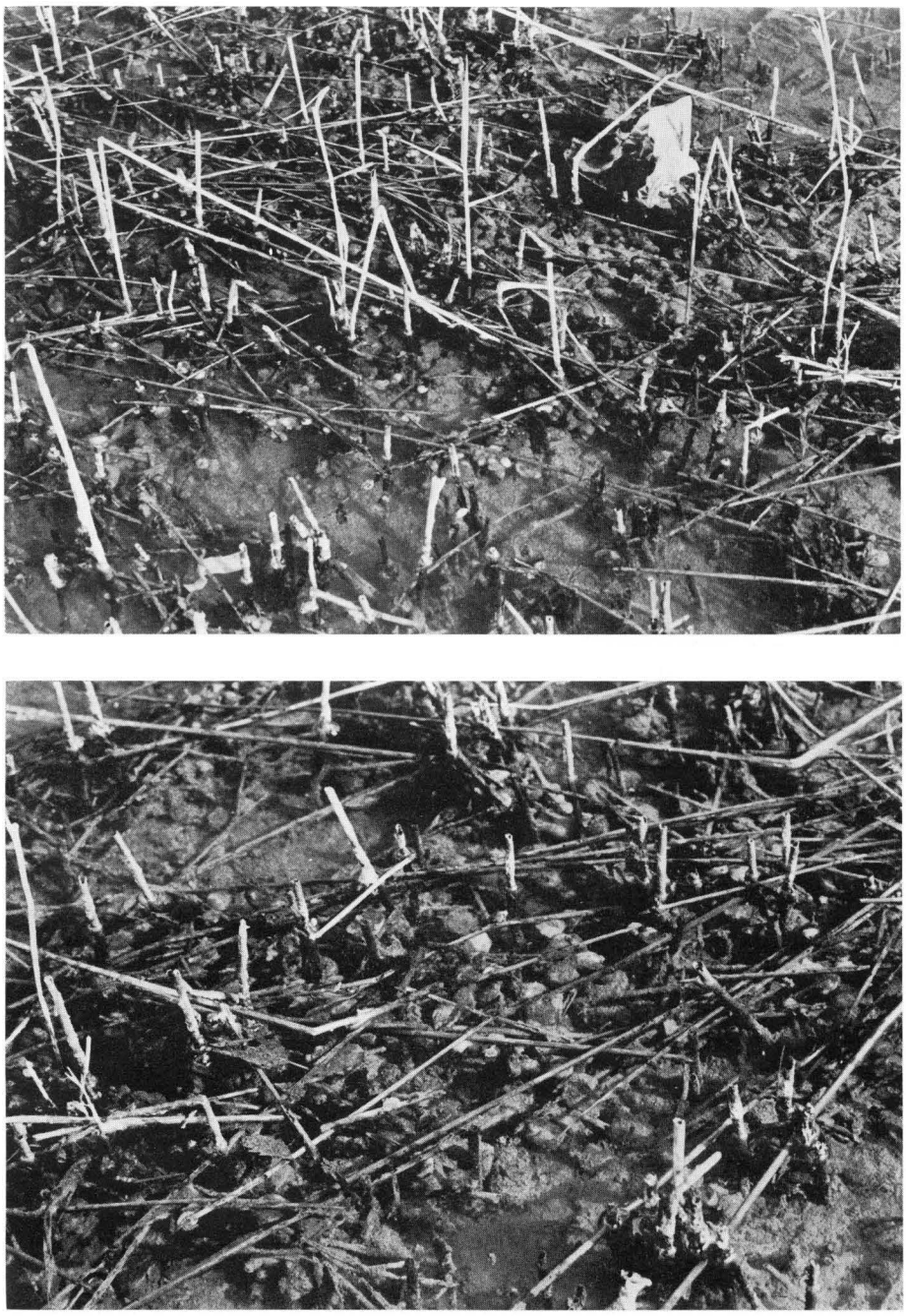

Fig. 3. Clusters of *Molgula manhattensis* (De Kay) formed on pipes of reed in the salty pond of Station 1, the bottom picture shows a close-up.

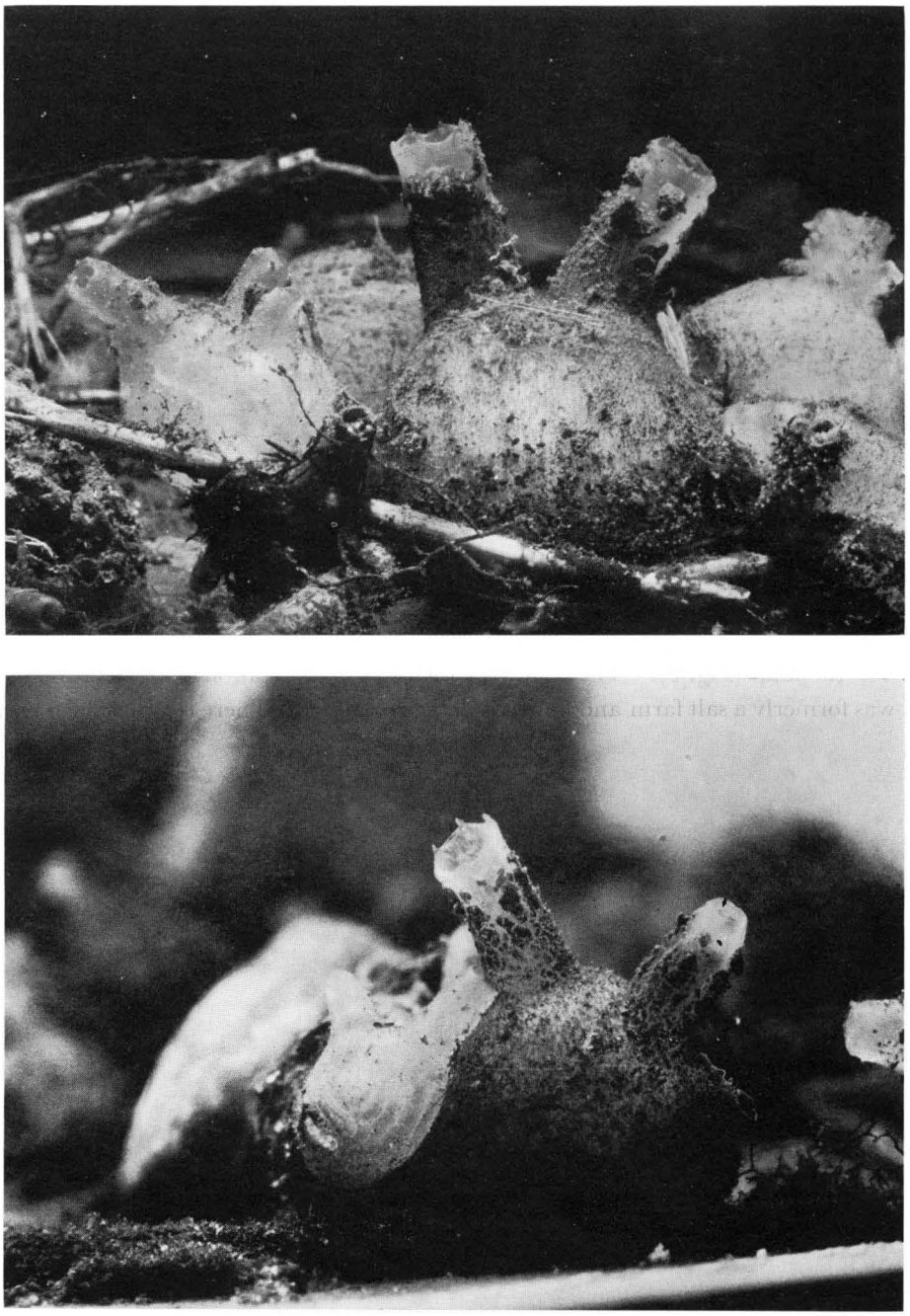

Fig. 4. *Molgula manhattensis* (De Kay) in the laboratory aquarium, the bottom picture shows a small, whitish and translucent individual (left) and a large individual, somewhat encrusted (right).

hand a possibility of immigration of the species from the Atlantic coasts of the United States by ships.

Hartmeyer (1923) was of the opinion that *M. manhattensis* is an amphi-Atlantic ascidian and united *Molgula tubifera* Oersted, 1844 (=*M. ampulloides* Van Beneden, 1846), a common species on the northern European coasts, with this American species. Van Name (1945), however, did not consider the identity of this European species with *M. manhattensis* as reliably established (p. 388). If the circumpolar distribution of the present species is accepted, then it must be very probable that *M. tubifera* is identical with *M. manhattensis*. If the specimens found in the Japanese waters were brought there by ships from the Atlantic coasts of the United States, then it must be very possible, too, that *M. tubifera* in northern European waters is nothing but *M. manhattensis* immigrated there by ships from the coasts of the United States, or vice versa. At any rate, the identity of *M. tubifera* with *M. manhattensis* has seemingly become more probable at the occurrence of the latter in the North Pacific.

Biological Notes

Locality and habitat: The ascidians were limited very strangely to a single salty pond of about 50m × 100m and 40cm deep at the maximum, shown as the Station No.1 in the map (Fig. 2). The wide area inclusive of this station and extending to the sea was formerly a salt farm and now it is being reclaimed. There remains several salty ponds in this area, but none of this ascidian has ever been found in any other ponds than the pond of Station 1. The water of the pond is led to the sea through a long salt-water canal, 5–10m in width and 1.5km in length, though the connection between the canal and the pond is indirect and very complicated. Thus, the canal water may be renewed at every tide, since it ebbs away to the bottom and flows to 3m deep, while the water level of the pond is changed by only some 10 cm according to the tide. Domestic sewage from the built-up area continuously pours into the inner end of the canal and the waste water from a cannery is shed into the canal near its outer end. In addition, there are two zinc refineries, respectively in the south of the railway station and on an island situated off the area, thus the area has been noted as being contaminated with zinc and cadmium. Naturally, the pond bottom is covered 5–10cm thick with mud, the dry weight of which is decreased by ignition by 10–15%.

The pond is vegetated thickly by reed (*Phragmites communis*) in the periphery and by a green alga (*Cladophora* sp.) in the water. Small animals, such as Japanese killifish (*Oryzias latipes*), a gastropod (*Haloa japonica*) and some amphipods (beach-flea) are found abundantly among the submersed pipes of reed.

Habitat water: During the period from February to April 1972, water samples were collected at five stations shown in the map (Fig. 2) and were examined in regard to pH, chlorinity and COD (after the potassium permanganate method); the results are given in the following.

Station no.	1	2	3	4	5
pH	7.3–8.0	7.8–8.0	7.1–8.0	8.0–8.2	8.3
Chlorinity (‰)	9.5–17.1	10.5–17.5	9.9–16.5	11.6–16.6	16.7–18.0
COD (ppm)	5–13	—	5–15	2–10	trace–3

The water nature of the pond of Station 1 is very unstable. Usually it is nearly as salty as the sea water, though somewhat polluted, but after a rainfall, it will become distinctly less saline (in chlorinity down to 9.5‰ in surface and 14.2‰ in bottom layer) and be accompanied with an extraordinarily high COD value up to 13. Evidently, such unusual conditions are brought about by drainage from the sewage treatment plant under construction at the end of the canal and also by the rubbish dump on one side of the pond.

Biology: Usually many ascidians are found attached to pipes of reed in the middle layer of water, crowded in some places so much that nearly every pipe of reed is furnished with clusters of animals (Fig. 3), which are formed around the pipe by attachment of smaller individuals to larger ones. In a case, a small 3 mm long individual was found attached to the branchial siphon of a larger specimen. Occasionally, larger individuals with a piece of pipe may be found lying solitarily on the muddy floor. On May 11, a 1m long pipe of vinyl chloride lying on the pond floor was found crowded with many (probably of half one hundred) of this ascidian. Larger animals closely resemble potatoes in shape and colour when siphons are contracted, but smaller ones are whitish and somewhat translucent (Fig. 4). It is observed in the laboratory aquarium that the distal part of both siphons is suddenly contracted and apertures are closed and then in a short time siphons recover slowly their extended state. Fully extended siphons are almost as long as the body, though they can be strongly contracted to insignificant tubercular processes.

The specimens collected in January were found already to have spent ovaries. However, intermittent discharge of a few eggs or a small amount of sperm from the atrial aperture was still observed in specimens collected on March 3. Thus, they seem to reproduce in the cold season, with an average atmospheric temperature of about 5°C in this district. The life span of this ascidian is still unconfirmed.

It is very strange that the distribution of this ascidian is limited strictly to a single small salty pond in a relatively wide area of Takehara City that has been surveyed so far. The present habitat may possibly be the only one survived the unfavourable conditions caused by expanding reclamation and building. Further distributional surveys of this ascidian, therefore, are needed especially in salt farm areas in the coastal region of the Inland Sea of Japan to answer the question whether this ascidian is a native or an immigrant.

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